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Stego in Multicarrier: A Phase Hidden Communication

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Abstract: Wireless communication is an incipient technique to increase portability, but is inept on grounds of security and capacity. Wireless communication coupled with multiple access techniques help in resolving these issues and aid in providing variable data rates. The security aspects can be palliated by using spread spectrum with information hiding mechanisms. This study analyses confidential data hiding using spread spectrum scheme added to Orthogonal Frequency Division Multiplexing (OFDM) system adopting different modulation schemes. Performance analysis is done with and without confidential data embedding considering Additive White Gaussian Noise (AWGN) channel. Code Division Multiple Access (CDMA) are compared and analysed with Multicarrier CDMA (MC CDMA) schemes using Bit Error Rate (BER) performance.

Key words: CDMA, MC-CDMA, steganography, AWGN, QPSK, QAM

INTRODUCTION

The present day processors are so fast that the data that need to be processed upon needs to be communicated should be able to synchronize with the pace. Wireless networks are widely used nowadays since they are simpler to implement and involve less complexity and power consumption. Hence, there is a need for improving the data rates through the system without affecting the message integrity. With the recent trends in the field of communication preferring wireless systems over the primitive wired systems, there is an utter need of security. The issue of security needs to be addressed to prevent the integrity and privacy of the message.

It has to be addressed seriously since any tapping or tampering of data can't be detected by any physical means as there is no physical channel is involved. MC-CDMA scheme couples CDMA and OFDM. This system is robust to frequency selective fading and provides efficient frequency usage. It has high spectral efficiency and facilitates the accommodation of more number of users than CDMA system. In OFDM, the serial data streams are converted into parallel bit streams utilizing orthogonal subcarriers. The entire bandwidth is subdivided into several lower rate narrow band channels thus reducing Inter Symbol Interference [ISI] (Praveenkumar *et al*., 2012a-c). The MC-CDMA system uses user specific PN sequence code that allows the data stream to be spread over the multiple sub carriers.

The near far problem occurring in the conventional CDMA systems hinder its performance efficiency. Also the use of rake receivers in multipath environment increases its complexity. But the MC-CDMA system uses orthogonal narrow band sub carriers and thus the channel is flat fading at each sub carrier (Hara and Prasad, 1996). Thus, the complexity of the receiver in an MC-CDMA system can be reduced through the efficient use of matched filters. IFFT and FFT. The OFDM principle is not popularly used because of the difficulties in generating, receiving and retrieving an OFDM signal (Kumar *et al*., 2011). But this problem can be easily solved if the signal is represented in frequency domain and the Inverse Fourier and Fourier transforms are used. IFFT and FFT are mainly used to spread the signal in time domain (Van Nee and Prasad, 2000; Thenmozhi *et al*., 2012). They reduce the number of multiplications and summations and make the implementation of OFDM easier and simpler. IFFT is used in the transmitter and FFT is used in the receiver side. In OFDM, the orthogonality of sub carriers can be maintained and the individual carriers can be effectively separated using FFT when there is no ISI, but that is not possible because there is a considerable amount of noise added in the channel.

From time immemorial, ways have been found out to protect the privacy of the message. Steganography is one such a technique that allows embedding a message in an image or such a multimedia file. Over the years focus has drifted from encoding the messages to suspicion free

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transmission i.e., the intruder is given no concrete information regarding the availability of the message. This is achieved by embedding the message in the file, called stego image, with very little alteration in the original file that is almost imperceptible to the hacker. To achieve this various techniques are employed (Amirtharajan and Balaguru, 2011, 2012a-d; Janakiraman *et al*., 2012).

One of the most primitive and simplest spatial domain methods is the Least Significant Bit (LSB) technique (Amirtharajan and Rayappan, 2012a-d; Janakiraman *et al*., 2012). Then the more efficient transform based techniques, distortion based techniques and Spread Spectrum Image Steganography (SSIS) (Marvel *et al*., 1998) were developed further that increased the imperceptibility of the hidden message. Amirtharajan and Balaguru (2011) proposed information hiding model using CDMA system. The process of detecting the presence of a message in a stego image is called stego analysis. The message needs to be absolutely imperceptible to the stego analysis failing which the whole system is assumed to have failed.

Steganography is often confused with cryptography and watermarking. Cryptography is the art of encoding a message using the sender or receiver's key generated each time the communication takes place (Schneier, 2007). The key prevents the intruder of reading the contents of the message. Watermarking is a form of steganography that protects the copyright of a file or prevents any modification to the file (Amirtharajan and Rayappan, 2012d, Amirtharajan *et al*., 2012). To detect and nullify these watermarks or message various algorithms have been put to use. Advanced techniques focus on distorting the message or watermark in the stego image (Karzenbeisser and Perircolas, 2000; Petitcolas *et al*., 1999) rendering it unusable without altering its basic attributes. To make the system completely fool proof various techniques and algorithms are being developed to conceal data. In this study, after reviewing the literature, the proposed method is focusing for transmitting data using CDMA and MCCDMA. The proposed Information embedding schemes employing CDMA and MCCDMA are studied in the presence of AWGN channel for BPSK, QPSK and QAM.

MATERIALS AND METHODS

The Multicarrier CDMA system model and the proposed hiding in the signal mapper are exhibited in Fig. 1 and 2 respectively. The transmitter of MC-CDMA system spreads the original data stream in the frequency domain over multiple sub carriers. Each sub carrier has its own spreading code. The spread signal is then modulated using a suitable technique and then IFFT of the modulated signal is taken. The signals are then summed and transmitted through the channel after appropriate Guard interval injection.

In MC-CDMA systems, the rate of transmission is not limited by the channel's frequency selective fading. Also it favors easier implementation and design. The adjacent orthogonal sub-carriers slightly overlap in the power spectrum. This sometimes leads to inter sub-carrier interference. Also the chips are longer in time duration and hence have narrow bandwidth.

In frequency domain, spreading is done. So, at the receiver end, received signal can make use of all the signal components spreaded in the frequency domain. The

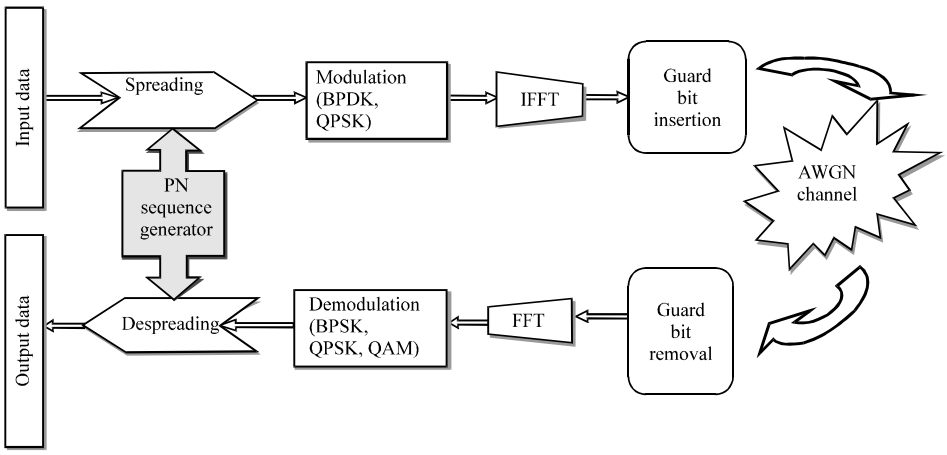

Fig. 1: Multi carrier CDMA system model

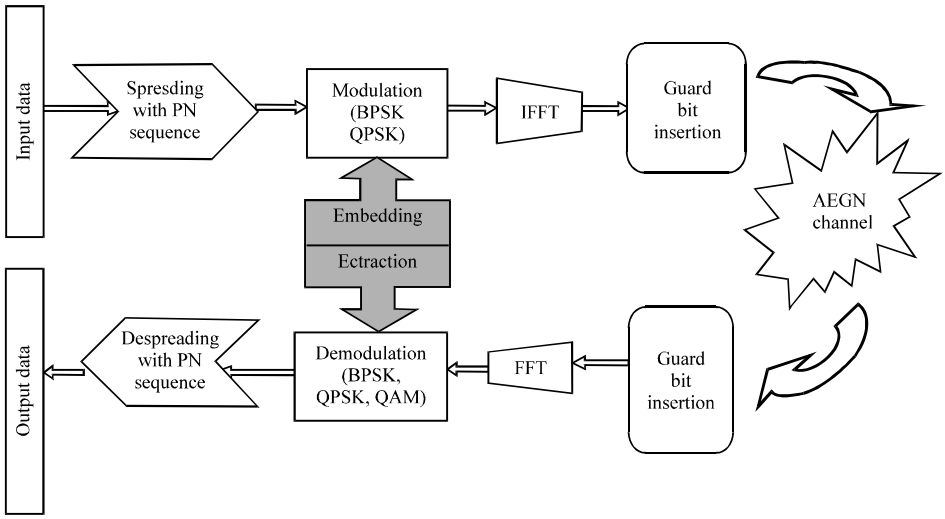

Fig. 2: Multi carrier CDMA Information hiding system model

received signal is then multiplied with orthogonal sub carriers to regain the transmitted signal of the particular user from the whole set of received signals and the resulting signals are demodulated and despread to retrieve the user data. At the same time additional secret data has been embedded along with regular CDMA and MCCDMA transmission schemes are found to be intact.

RESULTS AND DISCUSSION

MCCDMA and CDMA systems are examined based on the BER performance results through AWGN channel employing the three modulation schemes like BPSk, QPSk and QAM. The BER results employing each modulation scheme under CDMA and MC-CDMA are discussed in this section. The performance comparison of MC-CDMA using BPSK, QPSK and QAM modulation schemes are shown in Fig. 3-5.

The BER analysis has been carried out with and without embedding confidential information. It has been observed that the MC-CDMA scheme implemented using BPSK modulation shows better performance compared to other modulation schemes even after data embedding. This is mainly due to the OFDM principle introduced with spreading technique which uses bandwidth efficiently and reduces interference.

The comparative performance between CDMA and MCCDMA are shown in Fig. 6-8 which includes all the three modulation schemes such as BPSK, QPSK and QAM, respectively. In all the three modulation schemes MCCDMA supersedes CDMA in BER.

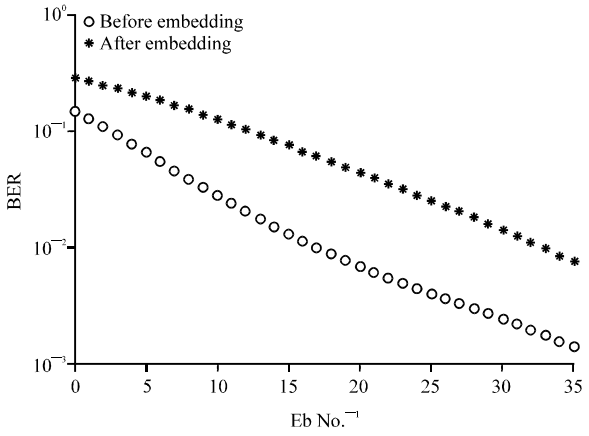

Fig. 3: Comparison of BPSK before and after embedding in MC-CDMA

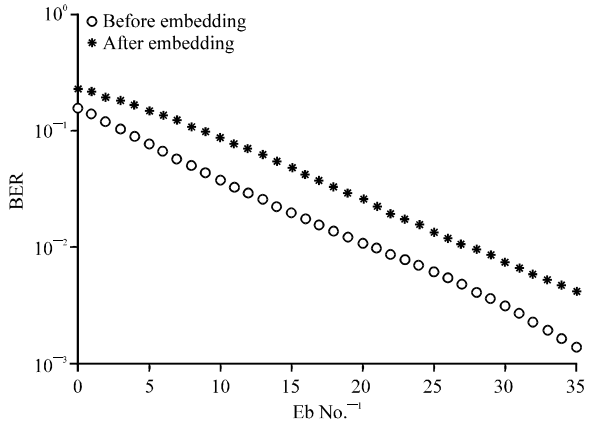

Fig. 4: Comparison of QPSK before and after embedding in MC-CDMA

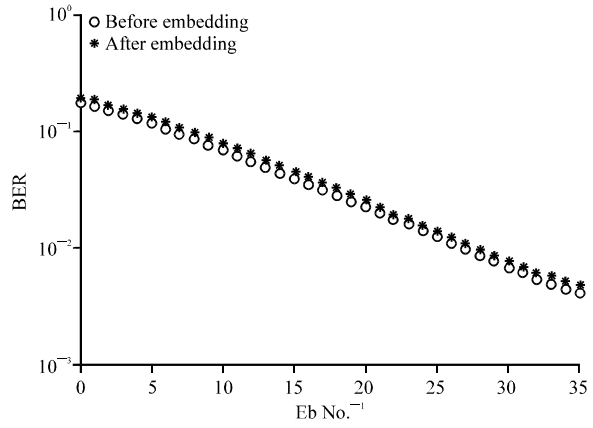

Fig. 5: Comparison of QAM before and after embedding in MC-CDMA

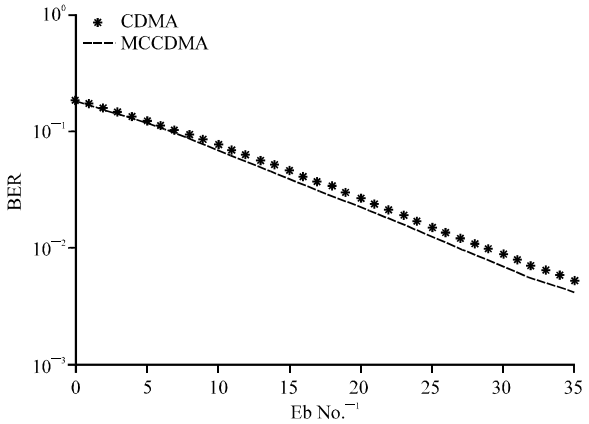

Fig. 8: MC-CDMA and CDMA schemes using QAM through AWGN channel

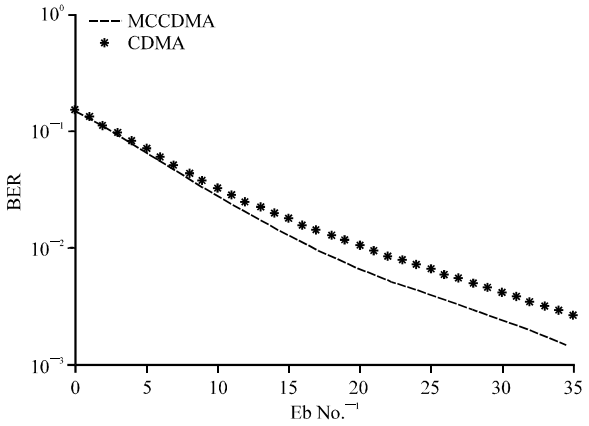

Fig. 6: MC-CDMA and CDMA schemes using BPSK through AWGN channel

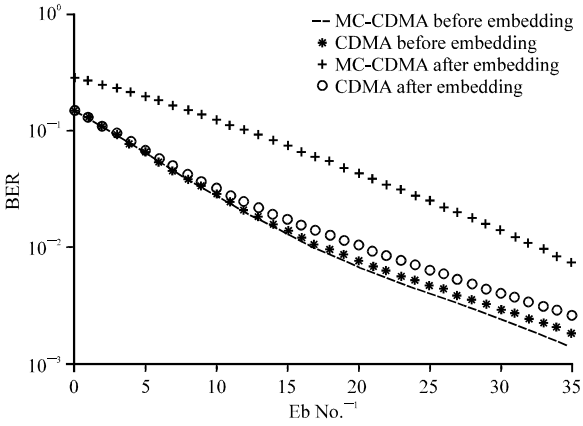

Fig. 9: MC-CDMA and CDMAschemes using BPSK before and after embedding

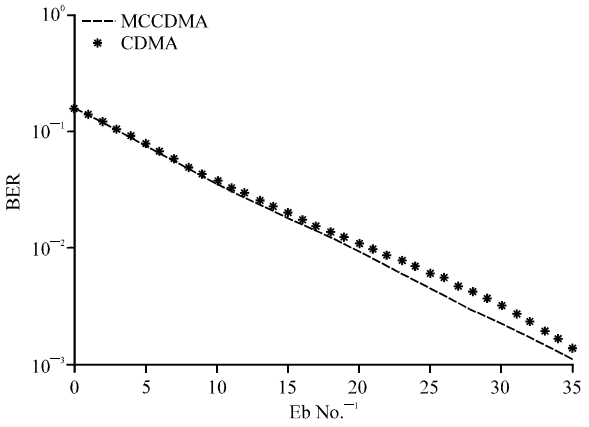

Fig. 7: MC-CDMA and CDMA c using QPSK in AWGN channel

The comparative performance analysis between MC-CDMA and CDMA schemes before and after embedding confidential information are shown in Fig. 9-11. Between these two schemes, MC-CDMA scheme using BPSK over rides other two modulation schemes and shows optimum BER performance.

From the BER results obtained, it is observed that the performances of the two aforementioned CDMA systems are not affected by means of the embedding process. But there will be a variation in the Bit Error Rate for the CDMA systems which uses embedded data. The BER value of MC CDMA systems will be comparatively optimum than the CDMA systems when using normal data as well as with embedding data also.

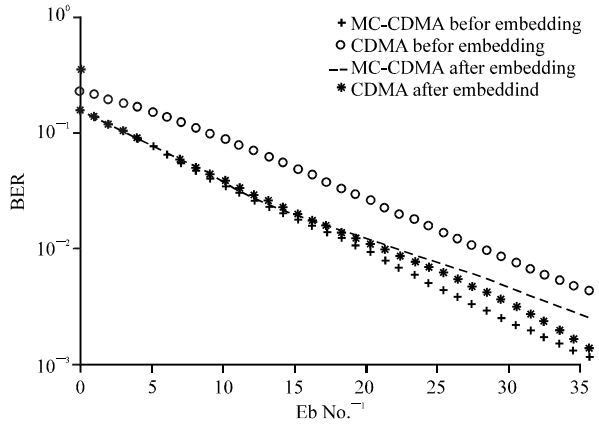

Fig. 10: MC-CDMA and CDMA schemes using QPSK before and after embedding

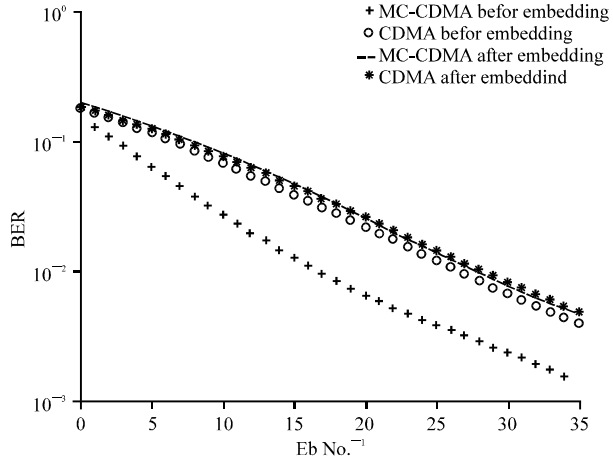

Fig. 11: Comparison between MC-CDMA and CDMA using QAM before and after embedding

CONCLUSION

Multiple access schemes were developed to solve the arising demands for a better and safer communication standard. Often, systems that support large data rate are preferable as bulk information has to be transmitted to several time critical applications nowadays. Owing to the growing needs, a method of combining OFDM and CDMA was proposed called the Multi Carrier CDMA (MC CDMA). These are preferred over CDMA systems because of bandwidth utilization and to eradicate ISI. MC-CDMA technique was used to spread the entire message into a wide band spectrum and modulate it with orthogonal subcarriers with eases the implementation even with frequency selective fading and multipath delay spreads. This technique improves the BER, spectral efficiency and reduces the transmitter-receiver complexity even for increased number of data with confidential information. BPSK proves to be better modulation scheme even after additional information when BER is considered. QAM provides better data rate comparatively at the expense of BER for both CDMA and Mc-CDMA schemes.

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